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Hagiwara et al.

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(54) **ELECTROCHEMICAL DEVICE**

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See application file for complete search history.

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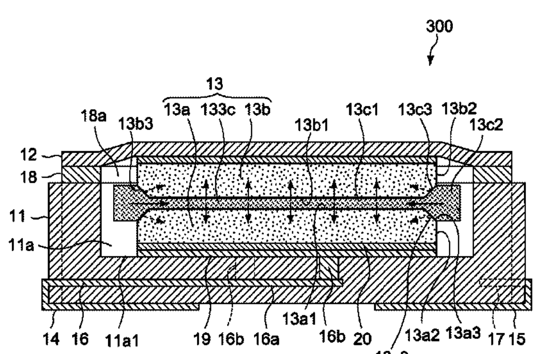
(57) **ABSTRACT**

An electrochemical device is provided with an electric storage element that is constituted by a first electrode sheet, a second electrode sheet, and a separator sheet installed between the two electrode sheets. The separator sheet includes: a first part (high liquid absorptivity part) sandwiched between the two electrode sheets; a second part (low liquid absorptivity part) extending outward from the two electrode sheets; and a third part (contact part) in contact with a rim surface of the second electrode sheet, whereby the electrochemical device can quickly and reliably resolve a phenomenon of the amount of electrolyte decreasing in the part of the separator sheet sandwiched between the two electrode sheets, even if the phenomenon occurs frequently.

4 Claims, 8 Drawing Sheets



(51) **Int. Cl.**

H01G 11/78	(2013.01)
H01G 11/26	(2013.01)
H01M 10/04	(2006.01)
H01M 10/0525	(2010.01)
H01M 10/0585	(2010.01)

(52) **U.S. Cl.**

CPC ***H01M 10/0436*** (2013.01); ***H01M 10/0463*** (2013.01); *H01M 10/0525* (2013.01); *H01M 10/0585* (2013.01); *H01M 2220/30* (2013.01); *Y02E 60/13* (2013.01)

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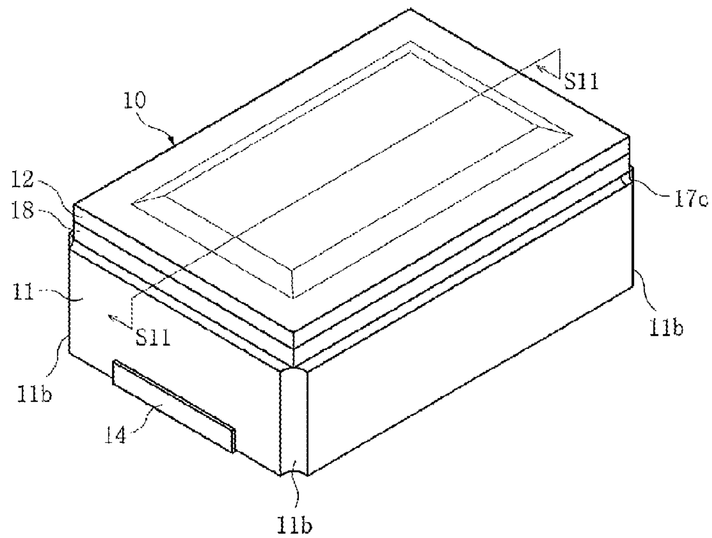
Fig. 1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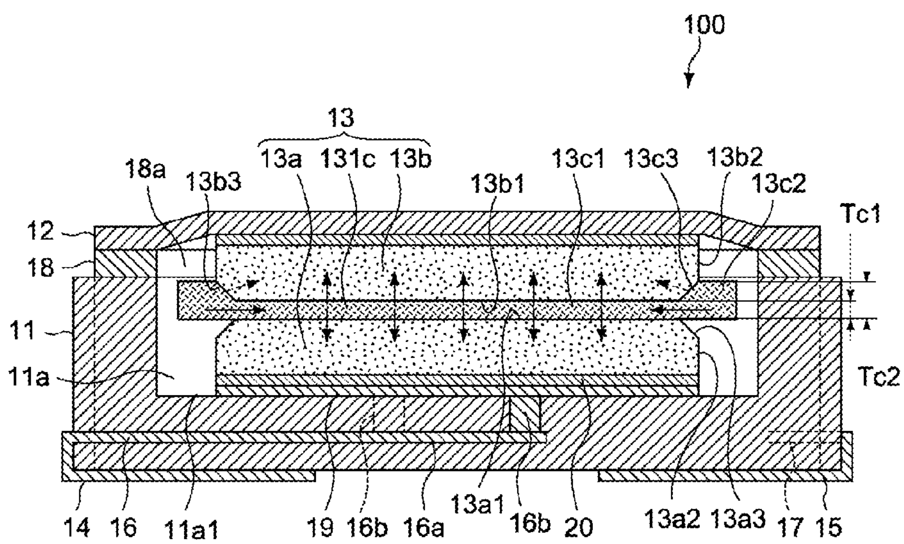
11b

Fig. 2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18a
13b3
13b1
13c1 13c3 13b2
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Tc1
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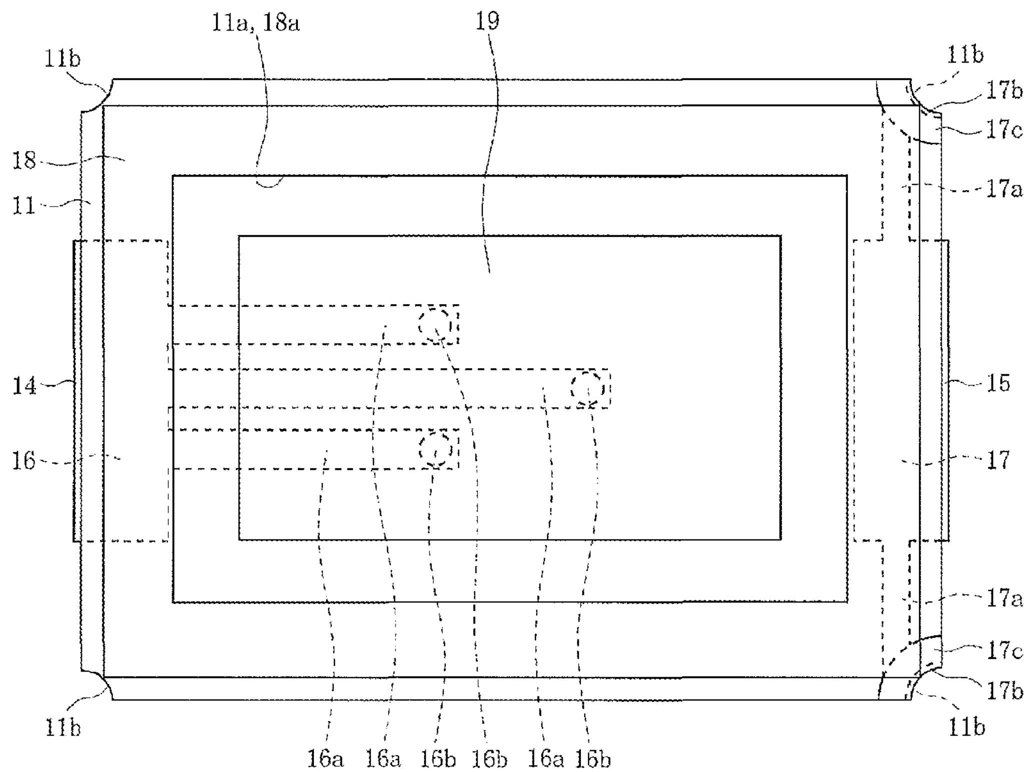
11a
Tc2
14 16 11a1 19 16b 16a 13a1 16b 20 13a2 13a3 17 15

Fig. 3



11a, 18a
19
11b
11b
17b
17c
18
17a
11
14
15
16
17
17a
17c
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11b
11b
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16a
16b
16b
16a
16b

Fig. 4

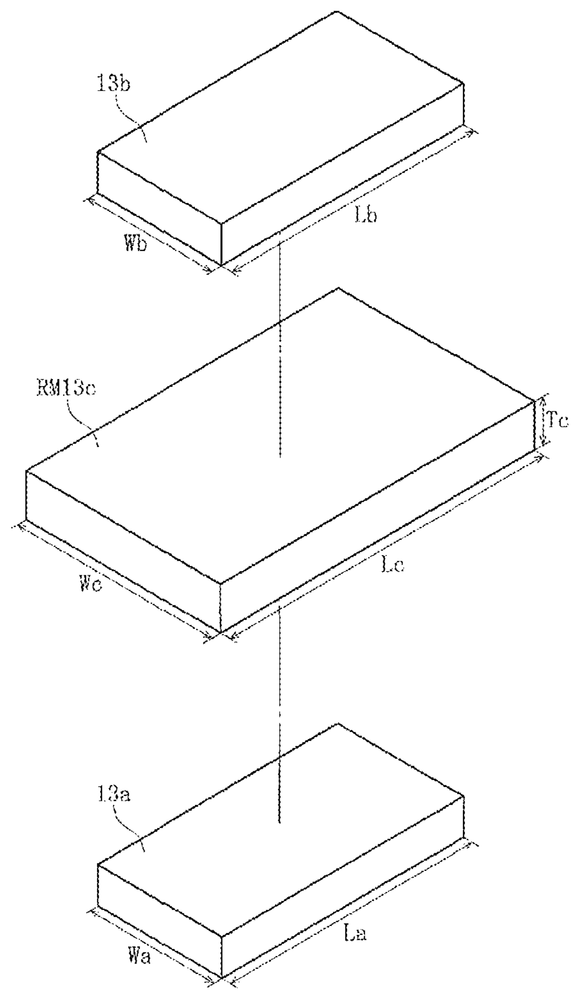
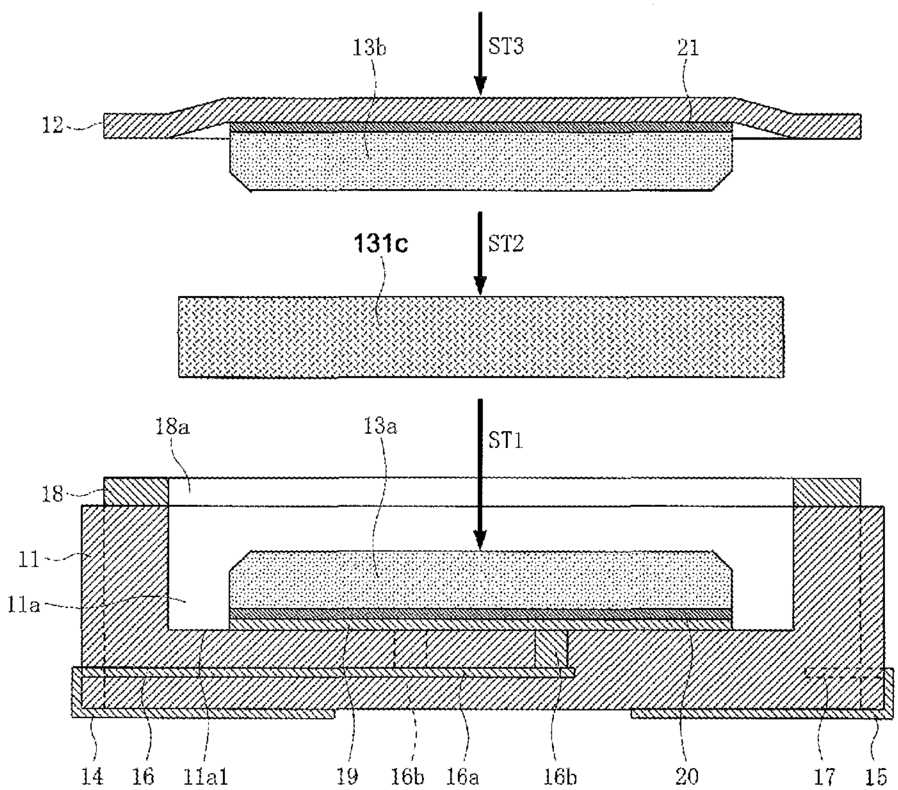


Fig. 5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ST1
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20
17
15

Fig. 6

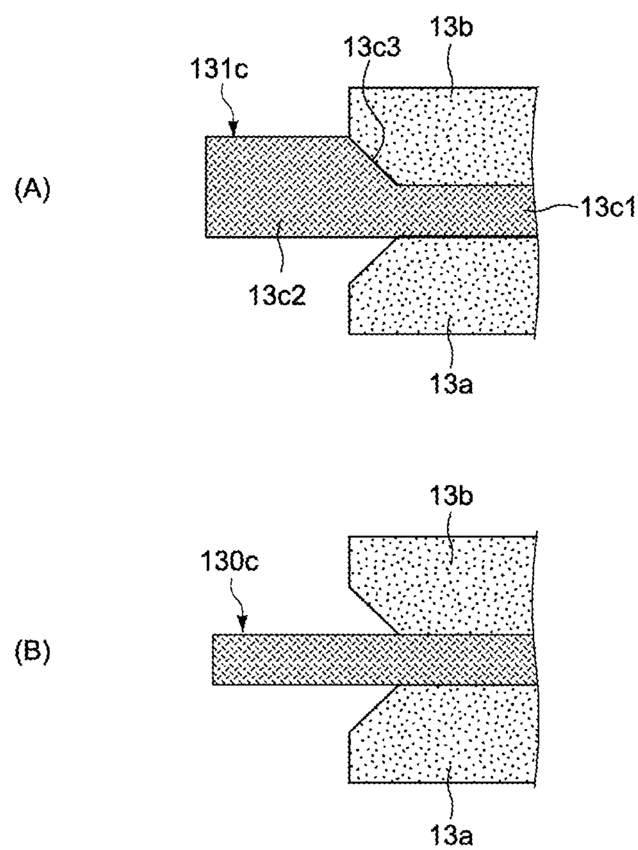
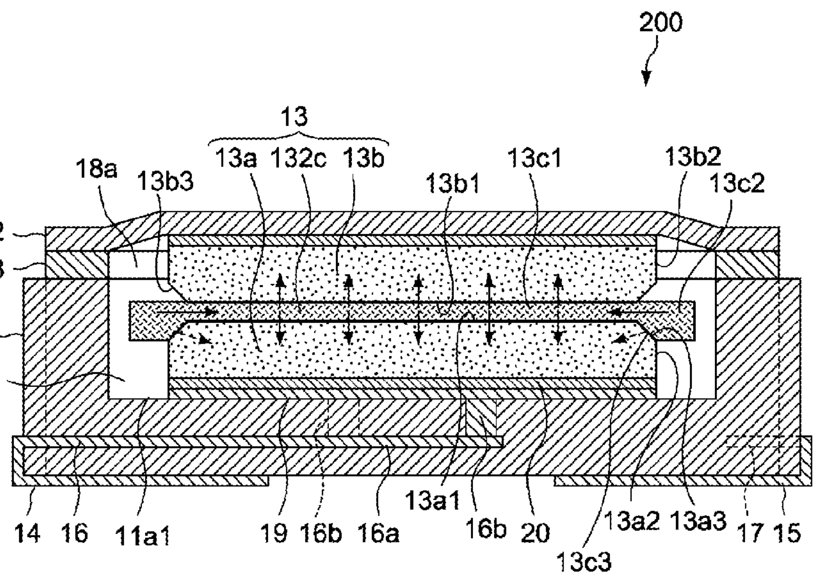


Fig. 7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13b2
13c2
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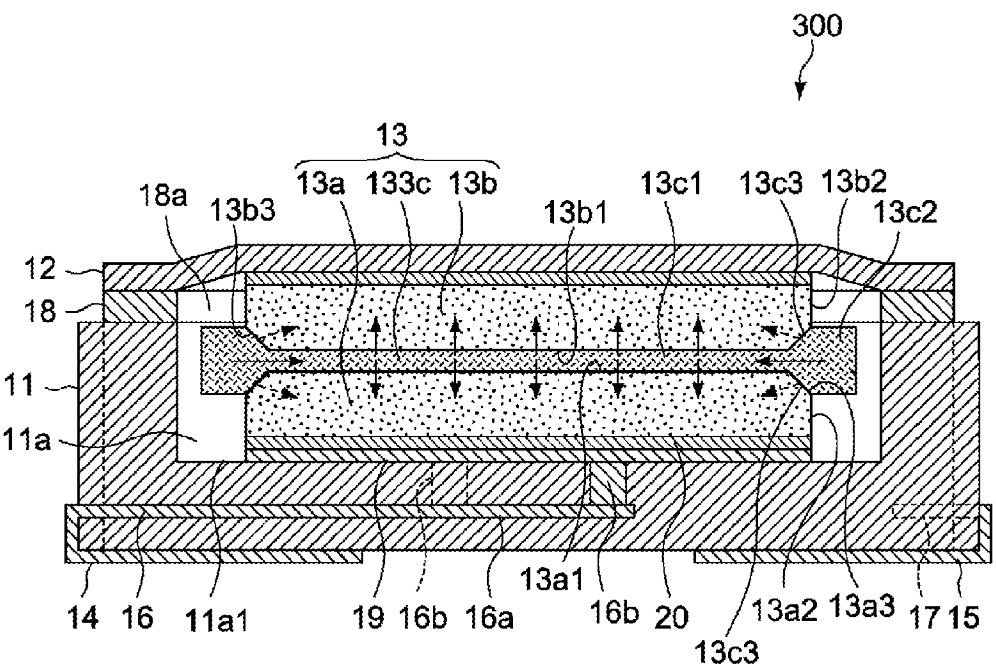
19 16b 16a
13a1
16b 20
13a2 13a3
17 15
13c3

Fig. 8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13c2
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19 16b 16a
13a1
16b 20
13a2 13a3
17 15
13c3

Fig. 9

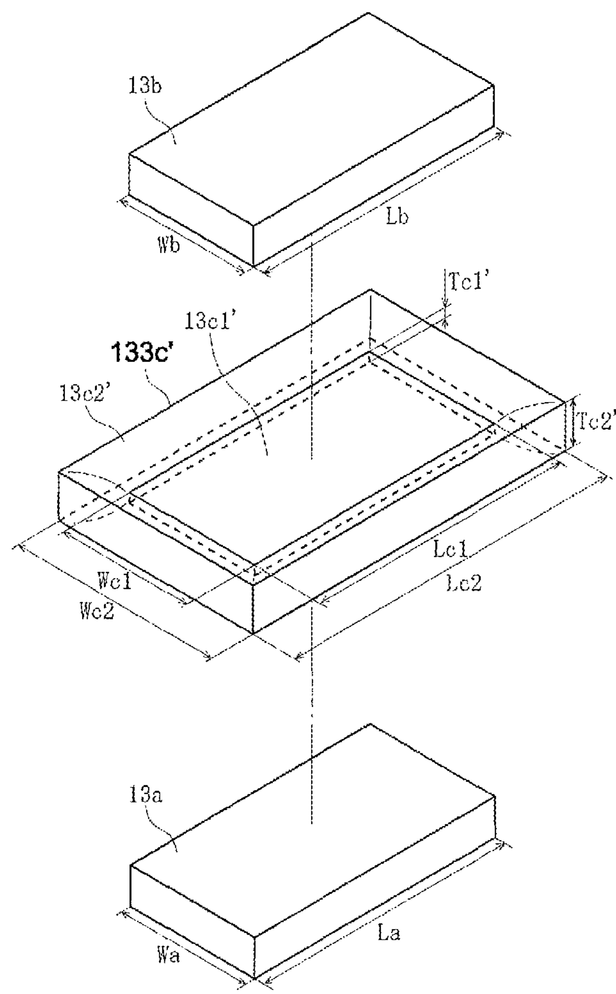
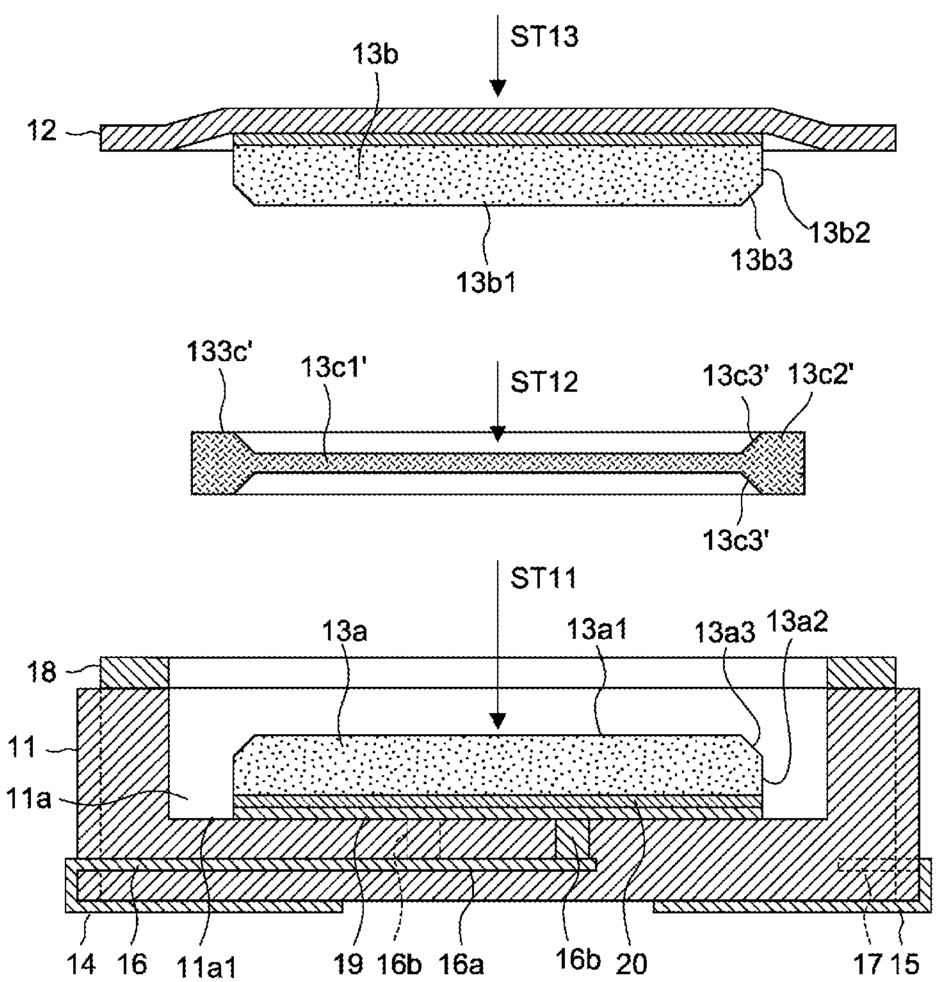


Fig. 10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13a
13a1
13a3
13a2
18
11
11a
14
16
11a1
19
16b
16a
16b
20
17
15

ELECTROCHEMICAL DEVICE

TECHNICAL FIELD

The present invention relates to an electrochemical device in which a chargeable/dischargeable electric storage element is sealed.

BACKGROUND ART

Mobile phones, notebook PCs, video cameras, digital cameras, and other electronic equipment use a surface-mountable electrochemical device, such as an electric double-layer capacitor or lithium ion battery, as their power source suitable for backing up the memory and the like.

This electrochemical device generally has: an insulating case with a concaved section constituting an opening in the top surface; a conductive lid that closes the concaved section of the case in a water-tight and air-tight manner; a chargeable/dischargeable electric storage element and electrolyte enclosed in the closed concaved section; a positive electrode terminal and negative electrode terminal provided on the mounting surface of the case; a positive electrode wiring for electrically connecting the positive electrode terminal and the positive electrode side of the electric storage element; and a negative electrode wiring for electrically connecting the negative electrode terminal and the negative electrode side of the electric storage element (refer to Patent Literature 1).

The electric storage element is constituted by a first electrode sheet of specified size made of active material, a second electrode sheet of specified size made of active material, and a separator sheet of specified size made of ion-permeating sheet, which are stacked together in the order of the first electrode sheet, separator sheet, and second electrode sheet. The outer periphery part of the separator sheet whose external dimensions are slightly larger than the external dimensions of the two electrode sheets extends slightly outward from the two electrode sheets. The material of the first electrode sheet may be the same as or different from the material of the second electrode sheet depending on the type of the electrochemical device.

Additionally, for the separator sheet whose functions include preventing the first electrode sheet and second electrode sheet from shorting with each other, retaining the electrolyte between the facing surfaces of the first electrode sheet and second electrode sheet, and allowing the ions to move in the retained electrolyte, a fiber-based porous sheet is generally used whose thickness is suitable for achieving these functions. For example, Patent Literature 2 describes a separator for electric double-layer capacitor constituted by a porous sheet and having a high-density layer with a void ratio of approx. 20 to 50% and low-density layer with a void ratio of approx. 50 to 80%.

With the aforementioned electrochemical device, the electrolyte is mostly impregnated into the first electrode sheet, second electrode sheet, and separator sheet and does not flow much in the charge/discharge process, but if the electrolyte in the two electrode sheets breaks down, deteriorates, or undergoes other change during this process, then the electrolyte impregnated into the part of the separator sheet sandwiched between the two electrode sheets may be drawn into the two electrode sheets, thus causing a phenomenon of the electrolyte in this part decreasing, albeit by a very small amount.

If this phenomenon occurs, the part of the separator sheet sandwiched between the two electrode sheets tries to draw in the amount of electrolyte corresponding to what has been drawn into the two electrode sheets, from the part of the separator sheet extending outward from the two electrode sheets. However, since the part of the separator sheet extending outward from the two electrode sheets has the same thickness and liquid absorptivity as the part sandwiched between the electrode sheets, it is difficult to instantly draw the electrolyte into the part sandwiched between the two electrode sheets from the part extending outward from the two electrode sheets. Also because the amount of electrolyte impregnated into the part extending outward from the two electrode sheets is very small, frequent occurrences of the aforementioned phenomenon will not prevent any decrease in the amount of electrolyte in the part of the separator sheet sandwiched between the two electrode sheets and, as a result of accumulation of this phenomenon, the charge/discharge characteristics will drop.

Note that the aforementioned term "liquid absorptivity" corresponds to the water absorption rate as measured by the Byreck method specified in JIS-L-1907. Also in the "Modes for Carrying Out the Invention" section of the Specification, mm/10 min is used as the unit of liquid absorptivity.

PRIOR ART LITERATURES

Patent Literatures

Patent Literature 1: Japanese Patent Laid-open No. 2009-278068

Patent Literature 2: Japanese Patent Laid-open No. 2008-85017

SUMMARY OF THE INVENTION

Problems to be Solved by the Invention

The object of the present invention is to provide an electrochemical device that can quickly and reliably resolve a phenomenon of the amount of electrolyte decreasing in the part of the separator sheet sandwiched between the two electrode sheets, even if the phenomenon occurs frequently.

Means for Solving the Problems

To achieve the aforementioned object, the electrochemical device pertaining to an embodiment of the present invention has a case, lid, and electric storage element.

The case has a concaved section constituting an opening.

The lid is coupled to the opening side of the case to form a closed section between itself and the concaved section.

The electric storage element includes a first electrode sheet, second electrode sheet and porous separator sheet. The first electrode sheet has a first principal surface and first rim surface formed around the first principal surface. The second electrode sheet has a second principal surface facing the first principal surface and second rim surface formed around the second principal surface. The separator sheet is installed between the first principal surface and second principal surface. The electric storage element is sealed inside the closed section and constituted in a chargeable/dischargeable manner.

In the aforementioned electrochemical device, the separator sheet has a first part, second part and third part.

The first part is placed between the first electrode sheet and second electrode sheet. The second part extends outward from the first electrode sheet and second electrode sheet. The third part is provided at least in one part of the second part and in contact with at least one of the first rim surface and second rim surface.

If the electrolyte in the two electrode sheets breaks down, deteriorates or undergoes other change during the charge/discharge process, then the electrolyte impregnated into the first part of the separator sheet sandwiched between the two electrode sheets may be drawn into the two electrode sheets, thus causing a phenomenon of the electrolyte in this part decreasing, albeit by a very small amount; according to the present invention, however, the electrolyte impregnated into the second part is instantly drawn into the first part according to the liquid absorptivity difference so that the first part is immediately replenished with electrolyte even if the aforementioned phenomenon occurs. Also because a considerable amount of electrolyte is impregnated into the second part, the first part is immediately replenished with electrolyte every time the aforementioned phenomenon occurs, even if it occurs frequently. In other words, the phenomenon of the amount of electrolyte decreasing in the part of the separator sheet sandwiched between the two electrode sheets can be resolved quickly and reliably, even if the phenomenon occurs frequently, thus preventing the charge/discharge characteristics from dropping as a result of accumulation of this phenomenon.

In addition, since the third part provided in at least one part of the second part is in contact with the rim surface of one of the electrode sheets, the phenomenon of the amount of electrolyte decreasing in the first part, which occurs as the electrolyte impregnated into the first part is drawn into the two electrode sheets, can be suppressed by the electrolyte-replenishing action from the third part to the applicable electrode sheet.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** External perspective view of the electrochemical device pertaining to the first embodiment of the present invention.

FIG. **2** Enlarged section view of the electrochemical device shown in FIG. **1** cut along line S**11**-S**11**.

FIG. **3** Enlarged top view of the case shown in FIG. **1**.

FIG. **4** Perspective view showing the constitution, prior to placement, of the electric storage element shown in FIG. **2**.

FIG. **5** Drawing for explaining how the base materials for first electrode sheet, second electrode sheet and separator as shown in FIG. **4** are placed (how the electric storage element is placed).

FIG. **6** (A) is a schematic section view of key parts of the electric storage element of the electrochemical device shown in FIG. **2**, while (B) is a schematic section view of key parts of the electric storage element of the electrochemical device pertaining to a comparative example.

FIG. **7** External perspective view of the electrochemical device pertaining to the second embodiment of the present invention.

FIG. **8** External perspective view of the electrochemical device pertaining to the third embodiment of the present invention.

FIG. **9** Perspective view showing the constitution, prior to placement, of the storage device of the electrochemical device pertaining to the fourth embodiment of the present invention.

FIG. **10** Drawing for explaining how the first electrode sheet, second electrode sheet, and separator sheet as shown in FIG. **9** are placed (how the electric storage element is placed).

MODES FOR CARRYING OUT THE INVENTION

Embodiments of the present invention are explained below by referring to the drawings.

First Embodiment

FIGS. **1** to **5** show the electrochemical device pertaining to the first embodiment of the present invention. An electrochemical device **100** shown in FIGS. **1** and **2** have a case **11**, lid **12**, electric storage element **13**, positive electrode terminal **14**, negative electrode terminal **15**, positive electrode wiring **16** and negative electrode wiring **17**.

<Constitution of Case>

The case **11** is made of alumina or other insulator material and formed in a manner constituting a rectangular solid shape of specified length, width and height. In addition, a concaved section **11***a* of specified depth and rectangular silhouette in top view is formed in the top surface of the case **11** to constitute an opening. In other words, the case **11** has an opening constituted by the concaved section **11***a* in its top surface and its bottom surface is used as the mounting surface. Additionally, when the case **11** is viewed from above, a cutout **11***b* whose silhouette in top view is roughly one-quarter of a circle is formed in the vertical direction in each of the four corners. Provided in this case **11** are the positive electrode terminal **14**, negative electrode terminal **15**, positive electrode wiring **16**, negative electrode wiring **17**, as well as a coupling ring **18** and current collector film **19**.

The positive electrode terminal **14** is made of gold or other conductor material and is formed in a manner constituting an L-shaped section extending from the center of one end face in the lengthwise direction to the bottom surface of the case **11** and also having a specified width. The negative electrode terminal **15** is made of gold or other conductor material and is formed in a manner constituting an L-shaped section extending from the center of the other end face in the lengthwise direction to the bottom surface of the case **11** and also having roughly the same width as the positive electrode terminal **14**.

Although not illustrated, if due to the material of the case **11** or for other reasons sufficient adhesion strength cannot be achieved by forming the positive electrode terminal **14** and negative electrode terminal **15** directly on the side and bottom surfaces of the case **11**, then ideally an adhesion support layer (such as one constituted by a tungsten membrane and nickel membrane arranged in this order from the case side) should be formed beforehand on the side and bottom surfaces of the case **11** to increase the adhesion strength of the positive electrode terminal **14** and negative electrode terminal **15** with respect to the side and bottom surfaces.

The positive electrode wiring **16** is made of tungsten or other conductor material and is formed inside the case **11** in a manner extending from the center of the one end face of the case **11** in the lengthwise direction to the bottom surface of the current collector film **19**. To be specific, as shown in FIG. **3**, the positive electrode wiring **16** has a part (not denoted by any symbol) having roughly the same width as the positive electrode terminal **14**, a total of three belt-shaped parts **16***a* extending inward from this part, and a total of three column-shaped parts **16***b* extending from the end of each belt-shaped part **16***a* to the current collector film **19**. The position of each column-shaped part **16***b* is different at a base of the concaved section **11***a* of the case **11**, and the top surface of each column-shaped part **16***b* is exposed at the base of the concaved section **11***a*. On the other hand, the part of the positive electrode wiring **16** exposed from the one end face of the case **11** in the lengthwise direction is electrically connected to the side surface part of the positive electrode terminal **14**.

The negative electrode wiring **17** is made of tungsten or other conductor material and is partially formed inside the case **11** in a manner extending from the center of the other end face in the lengthwise direction to the top surface of the case

11, with the remainder formed on the side and top surfaces of the case **11**. To be specific, as shown in FIG. **3**, the negative electrode wiring **17** has a part (not denoted by any symbol) having roughly the same width as the negative electrode terminal **15**, a total of two belt-shaped parts **17***a* extending outward from this part and positioned inside the case **11**, a total of two belt-shaped parts **17***b* continuing from the belt-shaped parts **17***a* and positioned on the interior surfaces of two cutouts **11***b* in the case **11**, and a total of two fan-shaped parts **17***c* continuing from the belt-shaped parts **17***b* and positioned on the top surface of the case **11**. In addition, the part of the negative electrode wiring **17** exposed from the other end face of the case **11** in the lengthwise direction is electrically connected to the side surface part of the negative electrode terminal **15**, while each fan-shaped part **17***c* of the negative electrode wiring **17** on the top surface of the case **11** is electrically connected to the bottom surface of the coupling ring **18**.

The coupling ring **18** (coupling member) is made of Kovar (iron-nickel-cobalt alloy) or other conductor material and is formed in a rectangular shape whose silhouette in top view is slightly smaller than the silhouette in top view of the case **11**. In addition, the silhouette in top view of an inner hole **18***a* of the coupling ring **18** is roughly identical to the silhouette in top view of the concaved section **11***a* of the case **11**. Since this coupling ring **18** is connected via a coupling member to the top surface of the case **11** in such a way that its inner hole **18***a* aligns with the concaved section **11***a*, the inner hole **18***a*, by working in cooperation with the concaved section **11***a*, virtually constitutes the concaved section.

Although not illustrated, if due to the material of the case **11** or for other reasons sufficient coupling strength cannot be achieved by coupling the coupling ring **18** directly onto the top surface of the case **11** using a joining member such as gold-copper alloy or other brazing material, then ideally a coupling support layer (such as one constituted by a tungsten membrane and nickel membrane arranged in this order from the top surface side) should be formed beforehand on the top surface of the case **11** to increase the coupling strength of the coupling ring **18** with respect to the top surface. Additionally, if the coupling ring **18** is made of any material having low corrosion resistance with respect to the electrolyte, then ideally a corrosion-resistance membrane (such as one constituted by a nickel membrane and gold membrane arranged in this order from the surface side or by a nickel membrane and platinum, silver, palladium, or other metal membrane instead of gold membrane) to increase the corrosion resistance with respect to the electrolyte should be formed beforehand on the surface (at least on the top and bottom surfaces and the interior surface of the inner hole **18***a*) of the coupling ring **18**.

The current collector film **19** is made of aluminum or other conductor material and is formed at the base of the concaved section **11***a* of the case **11** in a manner creating a silhouette in top view which is slightly smaller than the silhouette in top view of the base. In addition, the current collector film **19** formed at the base of the concaved section **11***a* of the case **11** is electrically connected to the exposed part of each column-shaped part **16***b* of the positive electrode wiring **16**.

Although not illustrated, if due to the material of each column-shaped part **16***b* of the positive electrode wiring **16** or for other reasons sufficient electrical conduction is not achieved between the current collector film **19** and the exposed part of each column-shaped part **16***b* by forming the current collector film at the base of the concaved section **11***a* of the case **11**, then ideally a conduction support layer (such as one constituted by a nickel membrane and gold membrane arranged in this order from the surface side of the projecting part) should be formed beforehand on the surface of the exposed part.

<Constitution of Lid and Coupling Method>

The lid **12** is coupled to the opening side of the case **11** to form a closed section (cell) between itself and the concaved section **11***a*. The lid **12** is made of Kovar (iron-nickel-cobalt alloy) or other conductor material, or preferably a clad material constituted by a Kovar base material with nickel membranes provided on its top and bottom surfaces, clad material constituted by a Kovar base material with nickel membranes provided on its bottom surface, or clad material using platinum, silver, gold, palladium, or other metal membranes instead of the nickel membranes, and is formed in a rectangular shape whose silhouette in top view is roughly identical to the silhouette in top view of the coupling ring **18**. Although the drawings show the lid **12** as one whose center part is raised in a rectangular shape, the lid **12** can also be such that it forms a planar shape.

After the electric storage element **13** is placed in the concaved section **11***a* of the case **11** (including the inner hole **18***a* of the coupling ring **18**), the outer periphery part of the bottom surface of the lid **12** is coupled to the top surface of the coupling ring **18** in an electrically conductive manner, and as a result of this coupling each concaved section **11***a* of the case **11** (including the inner hole **18***a* of the coupling ring **18**) is closed in a water-tight and air-tight manner. Coupling of the lid **12** onto the coupling ring **18** can be achieved by seam welding, laser welding or other direct joining method, or by any indirect joining method via a conductive joining member.

<Constitution of Electric Storage Element and Placement Method>

The electric storage element **13** is constituted by a first electrode sheet **13***a* of rectangular shape, second electrode sheet **13***b* of rectangular shape, and separator sheet **131***c* of rectangular shape installed between the two electrode sheets **13***a*, **13***b*. The first electrode sheet **13***a* and second electrode sheet **13***b* have a silhouette in top view which is smaller than the silhouette in top view of the concaved section **11***a* of the case **11**, while the separator sheet **131***c* has a silhouette in top view which is slightly larger than the silhouette in top view of the two electrode sheet **13***a*, **13***b* and slightly smaller than the silhouette in top view of the concaved section **11***a* of the case **11**.

The first electrode sheet **13***a* and second electrode sheet **13***b* are made of active carbon, PAS (polyacene semiconductor), or other active material, while the separator sheet **131***c* is made of a fiber-based porous sheet whose primary material is glass fiber, cellulose fiber, plastic fiber, etc. The material of the first electrode sheet **13***a* may be the same as or different from the material of the second electrode sheet **13***b* depending on the type of the electrochemical device **100**.

The first electrode sheet **13***a* has a principal surface **13***a***1** contacting the separator sheet **131***c* (first principal surface), outer side surface **13***a***2**, and rim surface **13***a***3** formed around the principal surface **13***a***1** (first rim surface). In this embodiment, the rim surface **13***a***3** is formed between the principal surface **13***a***1** and outer side surface **13***a***2** in a manner adjoining the principal surface **13***a***1**. The rim surface **13***a***3** is constituted by a planar or curved tapered surface formed in a manner cutting out the periphery of the principal surface **13***a***1**.

Similarly, the second electrode sheet **13***b* has a principal surface **13***b***1** contacting the separator sheet **131***c* (second principal surface), outer side surface **13***b***2**, and rim surface **13***b***3** formed around the principal surface **13***b***1** (second rim surface). In this embodiment, the rim surface **13***b***3** is formed between the principal surface **13**b**1** and outer side surface **13**b**2** in a manner adjoining the principal surface **13**b**1**. The rim surface **13**b**3** is constituted by a planar or curved tapered surface formed in a manner cutting out the periphery of the principal surface **13**b**1**.

The separator sheet **131**c has a first part **13**c**1** placed on (sandwiched between) the two electrode sheets **13**a, **13**b and second part **13**c**2** extending outward from the two electrode sheets **13**a, **13**b. The first part **13**c**1** and second part **13**c**2** are formed in a manner continuing to each other. The second part **13**c**2** is constituted to have lower liquid absorptivity than the first part **13**c**1**, and in the following explanations, the first part may also be referred to as the "high liquid absorptivity part," while the second part may also be referred to as the "low liquid absorptivity part."

The separator sheet **131**c further has a third part **13**c**3**. The third part **13**c**3** is provided at least in one part of the second part **13**c**2**, and in this embodiment, it is provided in the surface region of the second part **13**c**2** close to the second electrode sheet **13**b. The third part **13**c**3** is in contact with at least one part of the rim surface **13**b**3** of the second electrode sheet **13**b. In the following explanations, the third part may also be referred to as the "contact part."

The thickness (maximum thickness) Tc**2** of the low liquid absorptivity part **13**c**2** is greater than the thickness Tc**1** of the high liquid absorptivity part **13**c**1**, where the thickness ratio Tc**1**/Tc**2** is in a range of 0.3 to 0.8, for example. As explained later, the high liquid absorptivity part **13**c**1** is constituted by the crushed center part of the base material of separator sheet RM**13**c shown in FIG. **4**, while the low liquid absorptivity part **13**c**2** is constituted by the uncrushed outer periphery part of the base material of separator sheet RM**13**c.

This electric storage element **13** is sealed with the electrolyte (not illustrated) inside the concaved section **11**a closed by the lid **12** (including the inner hole **18**a of the coupling ring **18**). For the electrolyte, any known electrolyte, or specifically solution prepared by dissolving electrolyte salt in solvent or solvent-free ionic liquid, can be used as deemed appropriate. Specific examples of the former type of electrolyte (solution) include electrolytes whose solvent is chained sulfone, cyclic sulfone, chained carbonate, cyclic carbonate, chained ester, cyclic ester, nitrile, etc., containing lithium ions, quaternary ammonium ions, imidazolium ions, and other cations as well as BF4, PF6, TFSA, and other anions. Specific examples of the latter type of electrolyte (ionic liquid) include electrolytes containing imidazolium ions, pyridinium ions, quaternary ammonium ions, and other cations as well as BF4, PF6, TFSA, and other anions.

Also, as shown in FIG. **2**, the bottom surface of the first electrode sheet **13**a of the electric storage element **13** is electrically connected to the top surface of the current collector film **19** via a conductive adhesive layer **20**, while the top surface of the second electrode sheet **13**b is electrically connected to the bottom face of the lid **12** via a conductive adhesive layer **21**. These conductive adhesive layers **20**, **21** are cured conductive adhesive, and for this conductive adhesive, preferably thermosetting adhesive containing conductive grains, such as epoxy adhesive containing graphite grains, is used.

Here, the how the electric storage element **13** is placed is explained together with its constitution prior to placement. FIG. **4** schematically shows the constitution of the electric storage element **13** prior to placement. In the figure, **13**a represents the first electrode sheet, **13**b represents the second electrode sheet, and RM**13**c represents the base material of the separator sheet. In FIG. **4**, the rim surfaces **13**a**3**, **13**b**3** of the two electrode sheets **13**a, **13**b are not illustrated.

The first electrode sheet **13**a has a specified length La and width Wa, while the second electrode sheet **13**b has roughly the same length Lb and width Wb as the first electrode sheet **13**a. The material of the first electrode sheet **13**a and that of the second electrode sheet **13**b were explained earlier. The thickness of the sheets may be the same or different depending on the type of the electrochemical device **100**.

The base material of separator sheet RM**13**c has a specified length Lc, width Wc, thickness Tc, specified void ratio and liquid absorptivity (average), and hardness (flexibility) that allows it to be crushed by the two electrode sheets **13**a, **13**b. The length Lc of the base material of separator sheet RM**13**c is preferably greater by approx. 20 to 40% than the lengths La, Lb of the two electrode sheets **13**a, **13**b, while its width We is preferably greater by approx. 20 to 40% than the widths Wa, Wb of the two electrode sheets **13**a, **13**b. Also, the material of the base material of separator sheet RM**13**c is the same as the material of the separator sheet **131**c as explained earlier.

To place the electric storage element **13**, as shown in FIG. **5**, first uncured conductive adhesive is applied to the surface of the current collector film **19** and the bottom surface of the first electrode sheet **13**a is pressed against the conductive adhesive so that it adheres, after which the conductive adhesive is cured and then electrolyte is injected and thus impregnated into the first electrode sheet **13**a (refer to Step ST**1**). Next, the base material of separator sheet RM**13**c is placed on the top surface **13**a**1** of the first electrode sheet **13**a and then electrolyte is injected and thus impregnated into the base material of separator sheet RM**13**c (refer to Step ST**2**). Around the same time, the same uncured conductive adhesive is applied to the bottom surface of the lid **12** and the top surface of the second electrode sheet **13**b is pressed against the conductive adhesive so that it adheres, after which the conductive adhesive is cured and then electrolyte is injected and thus impregnated into the second electrode sheet **13**b. Next, the outer periphery part of the bottom surface of the lid **12** is overlaid onto the top surface of the coupling ring **18**, while at the same time the bottom surface **13**b**1** of the second electrode sheet **13**b is pressed against the top surface of the separator sheet **131**c (refer to Step ST**3**). Next, the lid **12** is coupled to the coupling ring **18**.

If the applicable polarities of the first electrode sheet **13**a and second electrode sheet **13**b constituting the electric storage element **13** are predetermined, then attention should be paid to the order of insertion with respect to each concaved section **11**a of the case **11** (including the inner hole **18**a of the coupling ring **18**) when the electric storage element **13** is placed in it. For example, if the applicable polarity of the first electrode sheet **13**a is set to positive and that of the second electrode sheet **13**b is set to negative, then the first electrode sheet **13**a on the positive electrode side should face the top surface of the current collector film **19**, while the second electrode sheet **13**b on the negative electrode side should face the bottom surface of the lid **12**.

In Step ST**3** mentioned above, the center part of the base material of separator sheet RM**13**c is crushed by the top surface of the first electrode sheet **13**a and bottom surface of the second electrode sheet **13**b, and this crushed part becomes the high liquid absorptivity part (first part) **13**c**1** of thickness Tc**1** (refer to FIG. **2**). The outer periphery part of the base material of separator sheet RM**13**c is not crushed, and therefore this uncrushed part becomes the low liquid absorptivity part (second part) **13**c**2** of thickness (maximum thickness) Tc**2** (refer to FIG. **2**), and this thickness (maximum thickness) Tc**2** is the same as the thickness Tc of the base material of separator sheet RM**13**c.

In this embodiment, an example where the contact part **13**c**3** of the separator sheet **131**c contacts the rim surface **13**b**3** of the second electrode sheet **13**b was explained; instead of this, however, the contact part **13**c**3** may be in contact with the rim surface **13**a**3** of the first electrode sheet **13**a, or the contact part **13**c**3** may be formed on both sides of the low liquid absorptivity part **13**c**2** so as to contact the rim surfaces **13**a**3**, **13**b**3** of the two electrode sheets **13**a, **13**b, respectively. The form of the contact part **13**c**3** can be set as deemed appropriate according to the initial shape of the separator sheet **131**c, shapes and sizes of the two electrode sheets **13**a, **13**b, and the amount by which the separator sheet **131**c is crushed by the two electrode sheets **13**a, **13**b, among others.

For example, any method can be adopted as deemed appropriate in order to stably form the contact part **13**c**3** of the separator sheet **131**c as shown in FIG. **2**, such as not forming the rim surface **13**a**3** of the first electrode sheet **13**a, or making the size (Wb and Lb) of the second electrode sheet **13**b smaller than the size (Wa and La) of the first electrode sheet **13**a, or forming the taper angle of the rim surface **13**b**3** of the second electrode sheet **13**b to be more gradual than the taper angle of the rim surface **13**a**3** of the first electrode sheet **13**a.

<Void Ratio and Liquid Absorptivity of Separator Sheet>

Here, the void ratios and liquid absorptivities of the high liquid absorptivity part **13**c**1** and low liquid absorptivity part **13**c**2** of the separator sheet **131**c are explained using specific examples.

According to an experiment, when a base material of separator sheet RM**13**c having a void ratio of 85% and liquid absorptivity (average) of 10 mm/10 min with respect to electrolyte (solution whose solvent was cyclic sulforane, cation was TEMA and anion was BF4 was used here) was used to obtain a separator sheet **131**c of 0.5 in thickness ratio Tc**1**/Tc**2** where Tc**1** represents the thickness of the high liquid absorptivity part **13**c**1** and Tc**2** represents the thickness (maximum thickness) of the low liquid absorptivity part **13**c**2**, then the void ratio of the high liquid absorptivity part **13**c**1** was approx. 70% and that of the low liquid absorptivity part **13**c**2** was approx. 84%, while the liquid absorptivity (average) of the high liquid absorptivity part **13**c**1** was 16 mm/10 min and that (average) of the low liquid absorptivity part **13**c**2** was 10.5 mm/10 min.

In this case, the void ratio (approx. 70%) of the high liquid absorptivity part **13**c**1** formed by crushing as mentioned earlier did not drop significantly compared to the void ratio (85%) of the base material of separator sheet RM**13**c or that (approx. 84%) of the low liquid absorptivity part **13**c**2**, because the void ratio of the base material of separator sheet RM**13**c used was high. According to other experiment, a void ratio of 70 to 90% could be ensured for the high liquid absorptivity part **13**c**1** when a base material of separator sheet RM**13**c with a void ratio of 85 to 95% was used, so long as the thickness ratio Tc**1**/Tc**2** was 0.5. In addition, the void ratio of the high liquid absorptivity part **13**c**1** did not drop significantly compared to the void ratio of the base material of separator sheet RM**13**c or that of the low liquid absorptivity part **13**c**2** when a base material of separator sheet RM**13**c with a void ratio of 85 to 95% was used, so long as the thickness ratio Tc**1**/Tc**2** was in a range of 0.3 to 0.8.

On the other hand, the liquid absorptivity (average: 16 mm/10 min) of the high liquid absorptivity part **13**c**1** formed by crushing as mentioned earlier improved significantly compared to the liquid absorptivity (average: 10 mm/10 min) of the base material of separator sheet RM**13**c or that (average: 10.5 mm/10 min) of the low liquid absorptivity part **13**c**2**, because the section sizes of the voids in the base material of separator sheet RM**13**c became smaller as a result of crushing as mentioned earlier. According to another experiment, a liquid absorptivity of 7 to 52 mm/min could be ensured for the high liquid absorptivity part **13**c**1** when a base material of separator sheet RM**13**c with a void ratio of 85 to 95% and liquid absorptivity (average) of 5 to 30 mm/10 min with respect to electrolyte was used, so long as the thickness ratio Tc**1**/Tc**2** was 0.5. In addition, the liquid absorptivity of the high liquid absorptivity part **13**c**1** improved significantly compared to the liquid absorptivity of the base material of separator sheet RM**13**c or that of the low liquid absorptivity part **13**c**2** when a base material of separator sheet RM**13**c with a void ratio of 85 to 95% was used, so long as the thickness ratio Tc**1**/Tc**2** was in a range of 0.3 to 0.8.

Effects Achieved by Electrochemical Device

First Embodiment

In the electrochemical device **100** according to this embodiment, the electrolyte is mostly impregnated into the first electrode sheet **13**a, second electrode sheet **13**b and separator sheet **131**c. The separator sheet **131**c has a low liquid absorptivity part **13**c**2** that extends outward from the two electrode sheets **13**a, **13**b and is thicker than the high liquid absorptivity part **13**c**1**, meaning that a considerable amount of electrolyte is impregnated into the low liquid absorptivity part **13**c**2**.

The electrolyte impregnated into the first electrode sheet **13**a, second electrode sheet **13**b and separator sheet **131**c does not flow much during the charge/discharge process, but if the electrolyte in the two electrode sheets **13**a, **13**b breaks down, deteriorates, or undergoes other change during this process, then the electrolyte impregnated into the part of the separator sheet **131**c sandwiched between the two electrode sheets **13**a, **13**b (high liquid absorptivity part **13**c**1**) may be drawn into the two electrode sheets **13**a, **13**b, thus causing a phenomenon of the electrolyte in this part decreasing, albeit by a very small amount (refer to the solid-line arrows pointing up and down in FIG. **2**).

According to the electrochemical device **100**, the electrolyte impregnated into the low liquid absorptivity part **13**c**2** is instantly drawn into the first high liquid absorptivity part **13**c**1** according to the liquid absorptivity difference so that the high liquid absorptivity part **13**c**1** is immediately replenished with electrolyte even if the aforementioned phenomenon occurs (refer to the solid-line arrows pointing to the left and right in FIG. **2**). Also, because a considerable amount of electrolyte is impregnated into the low liquid absorptivity part **13**c**2**, the high liquid absorptivity part **13**c**1** is immediately replenished with electrolyte every time the aforementioned phenomenon occurs, even if it occurs frequently. In other words, the phenomenon of the amount of electrolyte decreasing in the part of the separator sheet **131**c sandwiched between the two electrode sheets **13**a, **13**b (high liquid absorptivity part **13**c**1**) can be resolved quickly and reliably, even if the phenomenon occurs frequently, thus preventing the charge/discharge characteristics from dropping as a result of accumulation of this phenomenon.

Also because the contact part (third part) **13**c**3** provided in one part of the surface of the low liquid absorptivity part **13**c**2** is in contact with the rim surface **13**b**3** of the second electrode sheet **13**b, electrolyte is drawn in directly not only from the high liquid absorptivity part **13**c**1** to the second electrode sheet **13**b, but also from the low liquid absorptivity part **13**c**2** to the second electrode sheet **13**b via the contact part **13**c**3** (refer to the broken-line arrows in FIG. **2**) as the electrolyte in the second electrode sheet **13**b breaks down, deteriorates, or undergoes other change. In other words, the phenomenon of the amount of electrolyte decreasing in the high liquid absorptivity part **13**c**1**, which occurs as the electrolyte impregnated into the high liquid absorptivity part **13**c**1** is drawn into the second electrode sheet **13**b, can be suppressed by the electrolyte-replenishing action from the low liquid absorptivity part **13**c**2** and contact part **13**c**3** to the second electrode sheet **13**b.

Also, according to this embodiment, any insufficiency in the amount of electrolyte impregnated into the high liquid absorptivity part **13**c**1** of the separator sheet **131**c can be resolved and therefore the electrical continuity between the positive electrode and negative electrode can be maintained and rise in internal resistance prevented. In addition, characteristic changes associated with the use of an electrochemical device can be suppressed and stable production conditions in terms of yield and longevity can be determined.

The inventors of the present invention compared the electrical characteristics of the electrochemical devices having the electric storage elements shown in FIGS. **6** (A) and (B). FIG. **6** (A) shows a key part of the electric storage element of the electrochemical device shown in FIG. **2**. On the other hand, FIG. **6** (B) shows a key part of the electric storage element pertaining to a comparative example wherein such electric storage element has a separator sheet **130**c whose part placed between the two electrode sheets **13**a, **13**b and part extending outward from the two electrode sheets **13**a, **13**b are constituted at roughly the same thickness. These two separator sheets **131**c, **130**c are each constituted by the same material and are different only in terms of the form in which they are stored in the concaved section **11**a.

In the experiment, the initial internal resistance Ri [Ω] between the two electrode sheets **13**a, **13**b, internal resistance Ri [Ω] between the two electrode sheets **13**a, **13**b after charging, and yield [%], were compared, respectively, by changing the total amount of electrolyte injected into the cell. The results are shown in Table 1. In this example, the electric storage element was charged for 500 hours by continuously applying voltage and temperature (such as 3.3 V, 70° C.). The electrochemical devices in this embodiment and comparative example were produced to have the same capacitive density.

TABLE 1

	Amount injected [mg]	1.3	1.4	1.5	1.6	1.7	1.8
Embodiment	Initial internal resistance Ri [Ω]	110	95	93	93	93	93
	Internal resistance Ri [Ω] after 500 hours of charging	600	550	380	370	370	370
	Yield [%]	100	100	100	100	100	99.2
Comparative example	Initial internal resistance Ri [Ω]	140	93	93	93	93	—
	Internal resistance Ri [Ω] after 500 hours of charging	800	700	650	580	500	—
	Yield [%]	100	100	100	99.8	30	0

In the comparative example, the manufacturing yield dropped when the amount of electrolyte was 1.6 mg or more. This is because when the total amount of electrolyte exceeds the amount that can be held in the separator **130**c, the electrolyte overflows when the lid **12** is closed or enters the joint surface with the lid **12** to cause sealing failure. Accordingly, the drop in yield becomes more prominent as the amount of electrolyte increases.

Also in the comparative example, the internal resistance Ri after charging exhibited a tendency to rise more when there was less electrolyte. This is probably because continuous charging led to a decrease in the electrolyte retained in the part of the separator positioned between the two electrode sheets **13**a, **13**b, which caused the internal resistance Ri to rise.

As is evident from above, in the comparative example the tolerance center must be set near 1.45 mg if the tolerance is, for example, ±0.05 mg in the electrolyte injection step, which would cause the longevity traits to vary. Accordingly, it is difficult, in the comparative example, to determine stable production conditions in terms of yield and longevity, which necessitates design changes aimed at lowering the capacitive density.

In this embodiment, on the other hand, the yield was not affected when the amount of electrolyte was in a range of 1.7 mg or less, and the internal resistance stabilized when the amount of electrolyte was 1.6 mg or more. This is because the separator **131**c pertaining to this embodiment has the high liquid absorptivity part (first part) **13**c**1** and low liquid absorptivity part (second part) **13**c**2**, and thus is able to retain a greater amount of electrolyte than the separator **130**c pertaining to the comparative example.

Additionally, in this embodiment, while the internal resistance Ri after charging also exhibited a tendency to rise more when there was less electrolyte, the extent of rise could be kept lower than in the comparative example. This is because the separator **131**c pertaining to this embodiment has a contact part (third part) **13**c**3** in one part of the low liquid absorptivity part **13**c**2**, which is in contact with the rim surface **13**b**3** of the second electrode sheet **13**b, and this makes it possible to supply electrolyte from the contact part **13**c**3** to the electrode sheet **13**b and consequently keep any drop in the amount of solution in the high liquid absorptivity part **13**c**1** to less than that in the comparative example.

Furthermore in this embodiment, the internal resistance R was stable when the amount of electrolyte was 1.6 mg or more. Accordingly, the tolerance center can be set near 1.65 mg when the tolerance in the electrolyte injection step is ±0.05 mg, thus achieving more stable productivity and longevity traits. According to this embodiment, therefore, stable production conditions in terms of both yield and longevity can be determined.

Second Embodiment

FIG. **7** shows the electrochemical device pertaining to the second embodiment of the present invention. An electrochemical device **200** according to this embodiment is different from the aforementioned first embodiment in terms of the constitution of a separator sheet **132**c. The following primarily explains this constitution different from the first embodiment, and other constitutions identical to those in the aforementioned embodiment are denoted by the same symbols and their explanations are skipped or simplified.

The separator sheet **132**c in this embodiment has the high liquid absorptivity part (first part) **13**c**1** placed between the two electrode sheets **13***a*, **13***b*, low liquid absorptivity part (second part) **13***c***2** extending outward from the two electrode sheets **13***a*, **13***b*, and contact part (third part) **13***c***3** provided in the surface region of the low liquid absorptivity part **13***c***2** near the first electrode sheet **13***a*. The contact part **13***c***3** is constituted in such a way that it contacts at least one part of the rim surface **13***a***3** of the first electrode sheet **13***a*.

In this embodiment, the contact part (third part) **13***c***3** provided in one part of the surface of the low liquid absorptivity part **13***c***2** is in contact with the rim surface **13***a***3** of the first electrode sheet **13***a*, and therefore electrolyte is drawn in directly not only from the high liquid absorptivity part **13***c***1** to the first electrode sheet **13***a*, but also from the low liquid absorptivity part **13***c***2** to the first electrode sheet **13***a* via the contact part **13***c***3** (refer to the broken-line arrows in FIG. **7**) as the electrolyte in the first electrode sheet **13***a* breaks down, deteriorates, or undergoes other change. In other words, the phenomenon of the amount of electrolyte decreasing in the high liquid absorptivity part **13***c***1**, which occurs as the electrolyte impregnated into the high liquid absorptivity part **13***c***1** is drawn into the first electrode sheet **13***a*, can be suppressed by the electrolyte-replenishing action from the low liquid absorptivity part **13***c***2** and contact part **13***c***3** to the first electrode sheet **13***a*.

Any method can be adopted as deemed appropriate in order to stably form the contact part **13***c***3** of the separator sheet **132***c* as shown in FIG. **7**, such as not forming the rim surface **13***b***3** of the second electrode sheet **13***b*, or making the size (Wb and Lb) of the second electrode sheet **13***b* greater than the size (Wa and La) of the first electrode sheet **13***a*, or forming the taper angle of the rim surface **13***a***3** of the first electrode sheet **13***a* to be more gradual than the taper angle of the rim surface **13***b***3** of the second electrode sheet **13***b*.

Third Embodiment

FIG. **8** shows the electrochemical device pertaining to the third embodiment of the present invention. An electrochemical device **300** according to this embodiment is different from the aforementioned first embodiment in terms of the constitution of a separator sheet **133***c*. The following primarily explains structures different from the first embodiment, and other structures identical to those in the aforementioned embodiment are denoted by the same symbols and their explanations are skipped or simplified.

The separator sheet **133***c* in this embodiment has the high liquid absorptivity part (first part) **13***c***1** placed between the two electrode sheets **13***a*, **13***b*, low liquid absorptivity part (second part) **13***c***2** extending outward from the two electrode sheets **13***a*, **13***b*, and contact parts (third parts) **13***c***3** provided in the surface region of the low liquid absorptivity part **13***c***2** near the first electrode sheet **13***a* and that near the second electrode sheet **13***b*. Each contact part **13***c***3** is constituted in such a way that it contacts at least one part of the rim part **13***a***3**, **13***b***3** of the first or second electrode sheet **13***a*, **13***b*.

In this embodiment, the contact part (third part) **13***c***3** provided in one part of each surface of the low liquid absorptivity part **13***c***2** is in contact with the rim surface **13***a***3**, **13***b***3** of the first or second electrode sheet **13***a*, **13***b* and therefore electrolyte is drawn in directly not only from the high liquid absorptivity part **13***c***1** to the first and second electrode sheets **13***a*, **13***b*, but also from the low liquid absorptivity part **13***c***2** to the first and second electrode sheets **13***a*, **13***b* via the respective contact parts **13***c***3** (refer to the broken-line arrows in FIG. **8**) as the electrolyte in the first and second electrode sheets **13***a*, **13***b* breaks down, deteriorates, or undergoes other change. In other words, the phenomenon of the amount of electrolyte decreasing in the high liquid absorptivity part **13***c***1**, which occurs as the electrolyte impregnated into the high liquid absorptivity part **13***c***1** is drawn into the first and second electrode sheets **13***a*, **13***b*, can be suppressed by the electrolyte-replenishing action from the low liquid absorptivity part **13***c***2** and contact parts **13***c***3** to the first and second electrode sheets **13***a*, **13***b*.

Fourth Embodiment

FIGS. **9** and **10** show the fourth embodiment of the present invention, where FIG. **9** is an exploded perspective view of the electric storage element and FIG. **10** is an exploded perspective view of the electrochemical device.

The electrochemical device according to this embodiment is constituted in the same manner as with the electrochemical device **300** explained in the third embodiment, except that a separator sheet **133***c*' of the electric storage element **13** is comprised of a molded product having a high liquid absorptivity part (first part) **13***c***1**', low liquid absorptivity part (second part) **13***c***2**' and contact part (third part) **13***c***3**'. Other structures are identical to those in the first and third embodiments and their explanations are thus skipped.

The separator sheet **133***c*' shown in FIG. **9** is comprised of a base material of separator sheet RM**13***c* that has been press-formed to shape the high liquid absorptivity part **13***c***1**' and low liquid absorptivity part **13***c***2**' beforehand. To be specific, the center part of the base material of separator sheet RM**13***c* is pressed and crushed using a top die having the same shape as the top surface **13***a***1** of the first electrode sheet **13***a* and bottom die having the same shape as the bottom surface **13***b***1** of the second electrode sheet **13***b*, to form the high liquid absorptivity part **13***c***1**' with a thickness of Tc**1**'. Since the outer periphery part of the base material of separator sheet RM**13***c* is not crushed, the uncrushed part becomes the low liquid absorptivity part **13***c***2**' with a thickness (maximum thickness) of Tc**2**'. The thickness Tc**1**' of the high liquid absorptivity part **13***c***1**' and thickness Tc**2**' of the low liquid absorptivity part **13***c***2**' are not limited in any way and can be set to any thickness as deemed appropriate.

As explained earlier, the base material of separator sheet RM**13***c* has a hardness (flexibility) that allows it to be crushed, but if the base material of separator sheet RM**13***c* has strong elasticity, then the thickness Tc**1**' of the high liquid absorptivity part **13***c***1**' that has been formed by crushing may increase after crushing. In this case, ideally the heat needed to plasticize the high liquid absorptivity part **13***c***1**' should be applied at the same time when it is press-formed, followed by cooling after crushing, in order to maintain the thickness Tc**1**' of the high liquid absorptivity part **13***c***1**'.

To place the electric storage element **13**, as shown in FIG. **10**, first uncured conductive adhesive is applied to the surface of the current collector film **19** and the bottom surface of the first electrode sheet **13***a* is pressed against the conductive adhesive so that it adheres, after which the conductive adhesive is cured and then electrolyte is injected and thus impregnated into the first electrode sheet **13***a* (refer to Step ST**11**). Next, the bottom surface of the high liquid absorptivity part **13***c***1**' of the separator sheet **133***c*' is placed on the top surface **13***a***1** of the first electrode sheet **13***a* in an aligning manner and then electrolyte is injected and thus impregnated into the separator sheet **133***c*' (refer to Step ST**12**). Around the same time, the same uncured conductive adhesive is applied to the bottom surface of the lid **12** and the top surface of the second electrode sheet **13***b* is pressed against the conductive adhesive so that it adheres, after which the conductive adhesive is cured and then electrolyte is injected and thus impregnated into the second electrode sheet **13***b*. Next, the outer periphery part of the bottom surface of the lid **12** is overlaid onto the top surface of the coupling ring **18**, while at the same time the bottom surface **13***b***1** of the second electrode sheet **13***b* is placed on the top surface of the high liquid absorptivity part **13***c***1'** of the separator sheet **133***c*' in an aligning manner (refer to Step ST**13**). Next, the lid **12** is coupled to the coupling ring **18**.

If the applicable polarities of the first electrode sheet **13***a* and second electrode sheet **13***b* constituting the electric storage element **13** are predetermined, then attention should be paid to the order of insertion with respect to each concaved section **11***a* of the case **11** (including the inner hole **18***a* of the coupling ring **18**) when the electric storage element **13** is placed in it. For example, if the applicable polarity of the first electrode sheet **13***a* is set to positive and that of the second electrode sheet **13***b* is set to negative, then the first electrode sheet **13***a* on the positive electrode side should face the top surface of the current collector film **19**, while the second electrode sheet **13***b* on the negative electrode side should face the bottom surface of the lid **12**.

The section shape of the separator sheet **133***c*' after the placement of the electric storage element **13** is the same as the section shape of the separator sheet **133***c* shown in FIG. **8**, and the void ratio and liquid absorptivity of the separator sheet **133***c*' are also the same as the void ratio and liquid absorptivity of the separator sheet **133***c* shown in FIG. **8**.

Effects of Electrochemical Device

Fourth Embodiment

According to the aforementioned electrochemical device, the same effects as expected from the first and third embodiments described above can be achieved. In addition, because a recess is present on the bottom surface side of the high liquid absorptivity part **13***c***1'** of the separator sheet **133***c*' and this bottom surface shape is aligned with the top surface shape of the first electrode sheet **13***a*, and also because a recess is present on the top surface side of the high liquid absorptivity part **13***c***1'** and this top surface shape is aligned with the bottom surface shape of the second electrode sheet **13***b*, the bottom surface of the high liquid absorptivity part **13***c***1'** of the separator sheet **133***c*' can be positioned with the top surface of the first electrode sheet **13***a* easily and accurately when the former is placed on the latter, while at the same time the bottom surface of the second electrode sheet **13***b* can be positioned easily and accurately with the top surface of the high liquid absorptivity part **13***c***1'** of the separator sheet **133***c*' when the former is placed on the latter.

The foregoing explained embodiments of the present invention; however, the present invention is not limited to the aforementioned embodiments and it goes without saying that various changes may be added so long as doing so does not cause the present invention to deviate from its key points.

For example, while the rim surface **13***a***3**, **13***b***3** of the electrode sheet contacted by the contact part **13***c***3** of the separator sheet is formed between the principal surface **13***a***1**, **13***b***1** and outer side surface **13***a***2**, **13***b***2** in the examples explained under the foregoing embodiments, this rim surface may be any surface so long as the surface is formed around the principal surface **13***a***1**, **13***b***1**, and the outer side surface **13***a***2**, **13***b***2** may be applied as this rim surface, for example.

In addition, the contact part **13***c***3** of the separator sheet need not be constituted in a manner continuously contacting the entire region of the rim surface of the electrode sheet, but it may contact only at least one part of the rim surface instead. Alternatively, the contact part **13***c***3** need not be formed continuously along the periphery of the low liquid absorptivity part **13***c***2**, but it may be formed non-continuously (intermittently), for example, because such constitution still allows the same operations and effects as described above to be achieved.

DESCRIPTION OF THE SYMBOLS

100, **200**, **300**—Electrochemical device
11—Case
11*a*—Concaved section
12—Lid
13—Electric storage element
13*a*—First electrode sheet
13*b*—Second electrode sheet
131*c*, **132***c*, **133***c*, **133***c*'—Separator sheet
13*c***1**, **13***c***1'**—High liquid absorptivity part
13*c***2**, **13***c***2'**—Low liquid absorptivity part
13*c***3**, **13***c***3'**—Contact part

What is claimed is:

1. An electrochemical device comprising:
a case with a concaved section constituting an opening;
a lid coupled to an opening side of the case to form a closed section between itself and the concaved section; and
an electric storage element that includes
a first electrode sheet having a first principal surface and a first rim surface formed around the first principal surface, said first rim surface being constituted by a planar or curved tapered surface formed by removing a periphery edge of the first principal surface,
a second electrode sheet having a second principal surface facing the first principal surface and a second rim surface formed around the second principal surface, said second rim surface being constituted by a planar or curved tapered surface formed by removing a periphery edge of the second principal surface, and
a porous separator sheet installed between the first principal surface and second principal surface and capable of retaining an electrolyte,
said electric storage element being sealed inside the closed section and constituted in a chargeable/dischargeable manner;
wherein the separator sheet has:
a first part placed between the first electrode sheet and second electrode sheet and crushed by the first principal surface and second principal surface;
a second part extending outward from the first electrode sheet and second electrode sheet; and
a third part provided at least in one part of the second part and placed in contact entirely with at least one of the first rim surface and second rim surface by being pressed against at least one of the first rim surface and second rim surface, said third part being capable of supplementing the electrolyte;
wherein at least one of the first rim surface and second rim surface is provided between an outer side surface of the first electrode sheet and the first principal surface or between an outer side surface of the second electrode sheet and the second principal surface.

2. An electrochemical device according to claim **1**, wherein the first rim surface is provided between an outer side surface and the first principal surface of the first electrode sheet, and the third part is in contact with the first rim surface, said outer side surface being perpendicular to and surrounding the first principal surface.

3. An electrochemical device according to claim **1**, wherein the second rim surface is provided between an outer side surface and the second principal surface of the second electrode sheet, and the third part is in contact with the second rim surface.

4. An electrochemical device according to claim **2**, wherein the second rim surface is provided between an outer side surface and the second principal surface of the second electrode sheet, and the third part is in contact with the second rim surface.

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